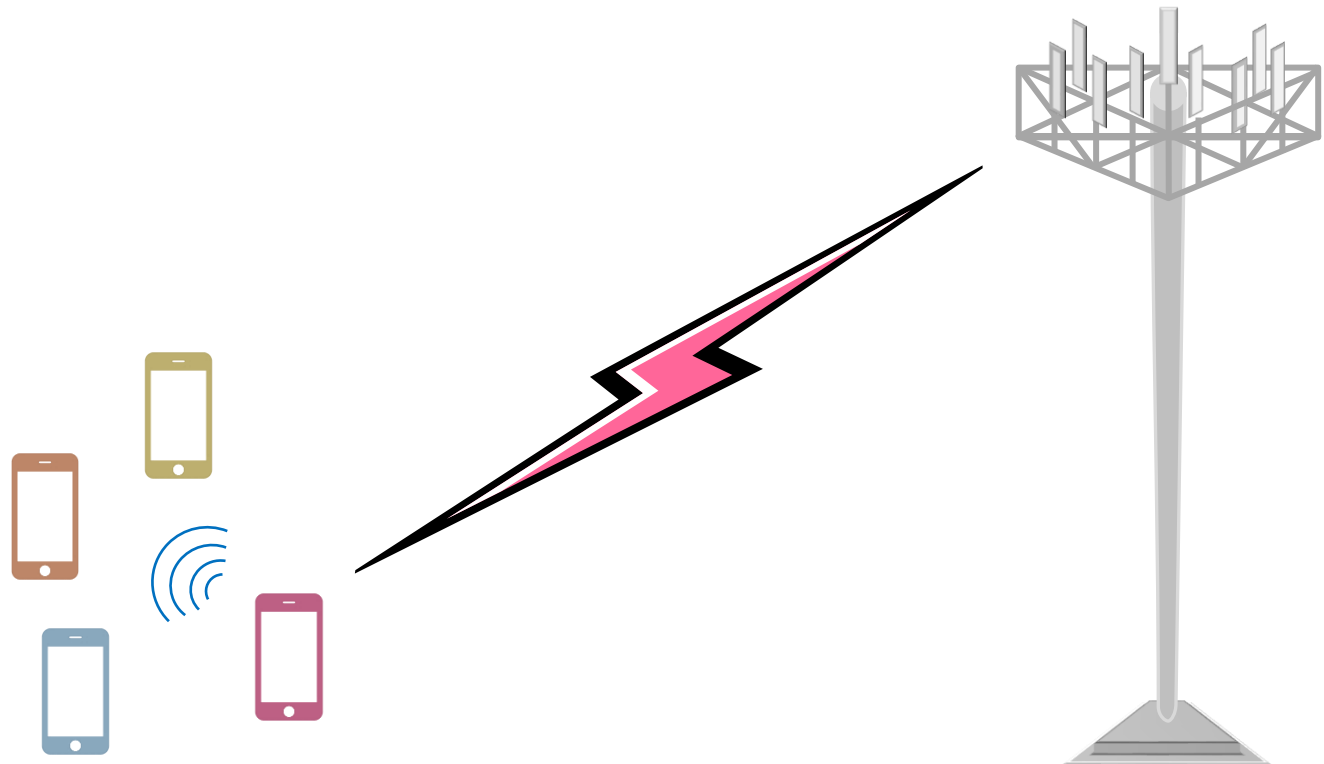
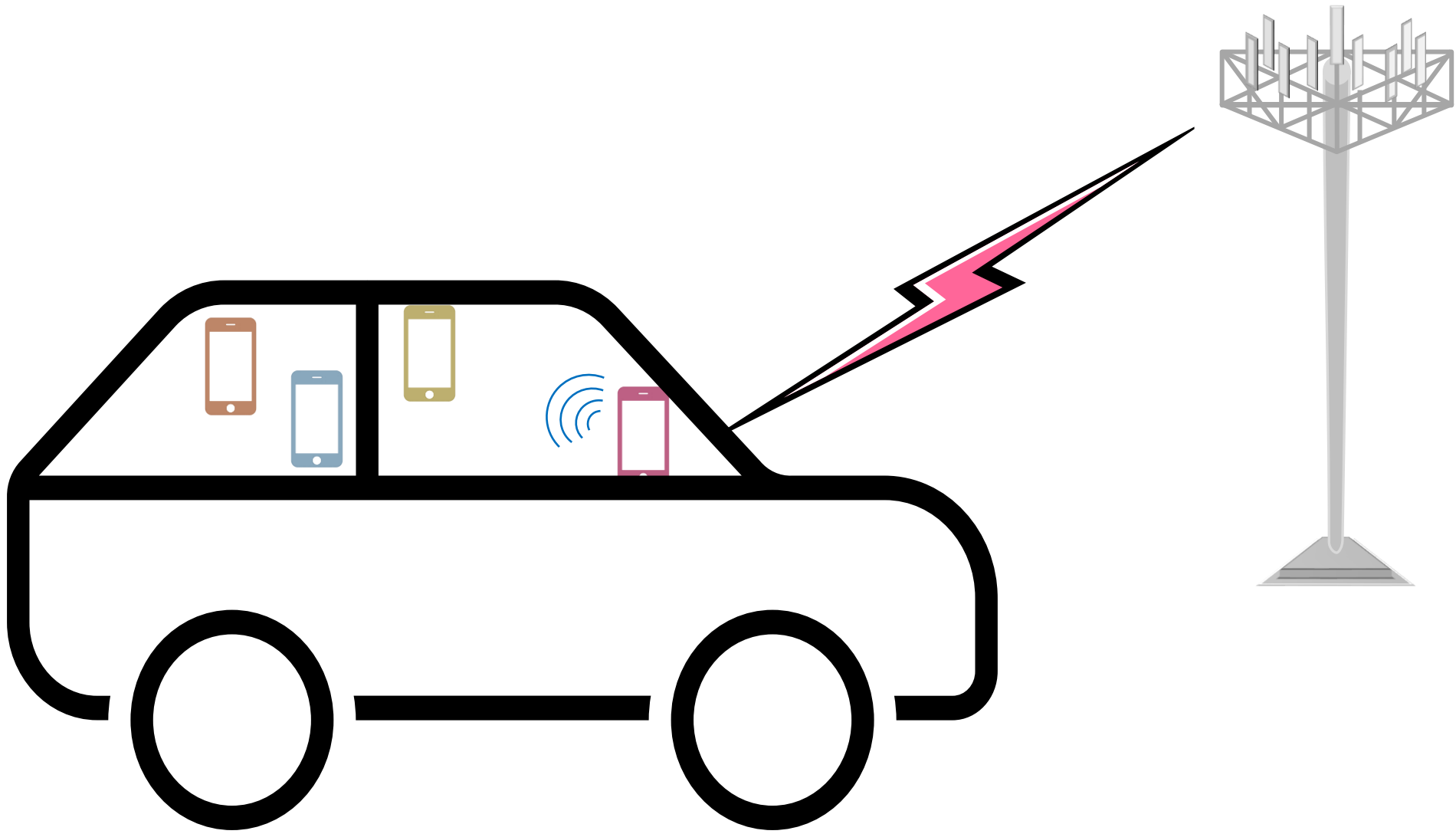


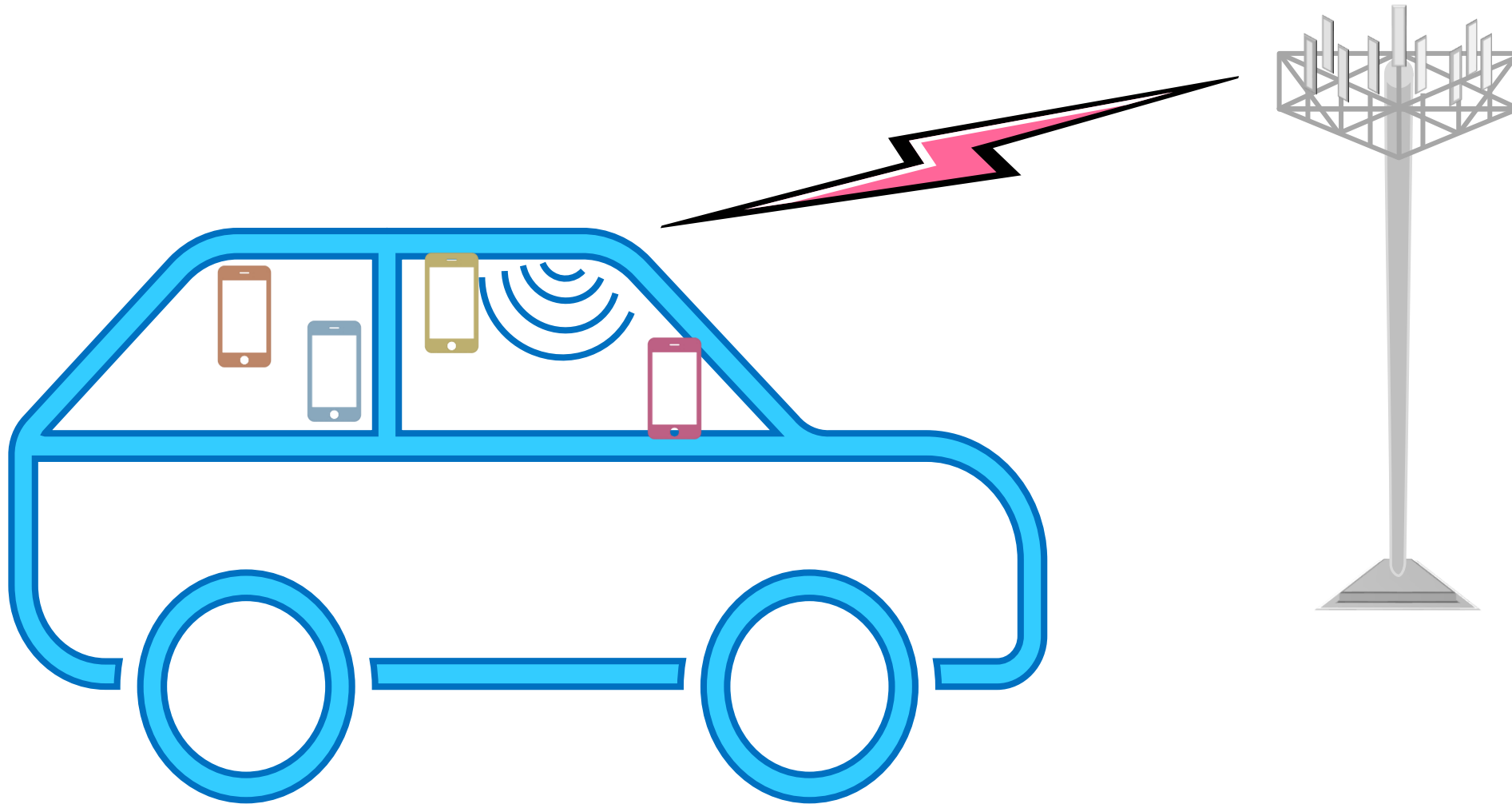
Connected and Autonomous Vehicles (CAVs)







The Connected Car

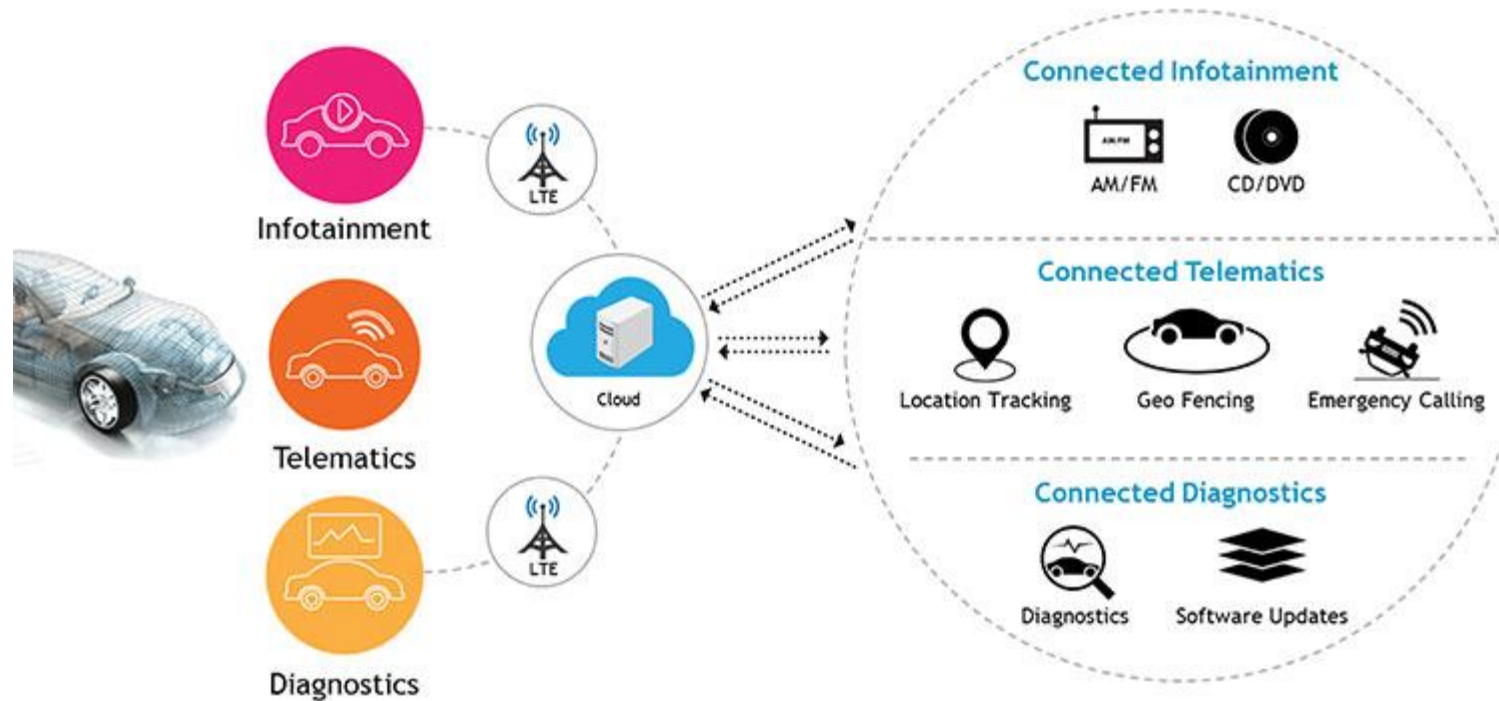


Connected Car: Use cases & requirements

Use Cases	Requirements	Applications
Infotainment	High Bandwidth	<ul style="list-style-type: none">• Browsing• Entertainment• Media (audio, video)• Video conferencing, etc.
Traffic Efficiency	Reliability	<ul style="list-style-type: none">• Navigation• Live Traffic Information• Toll
Traffic Safety	Low latency, High reliability	<ul style="list-style-type: none">• Hazard warning• Collision warning• Co-operative autonomous cruise control

Source: ETSI

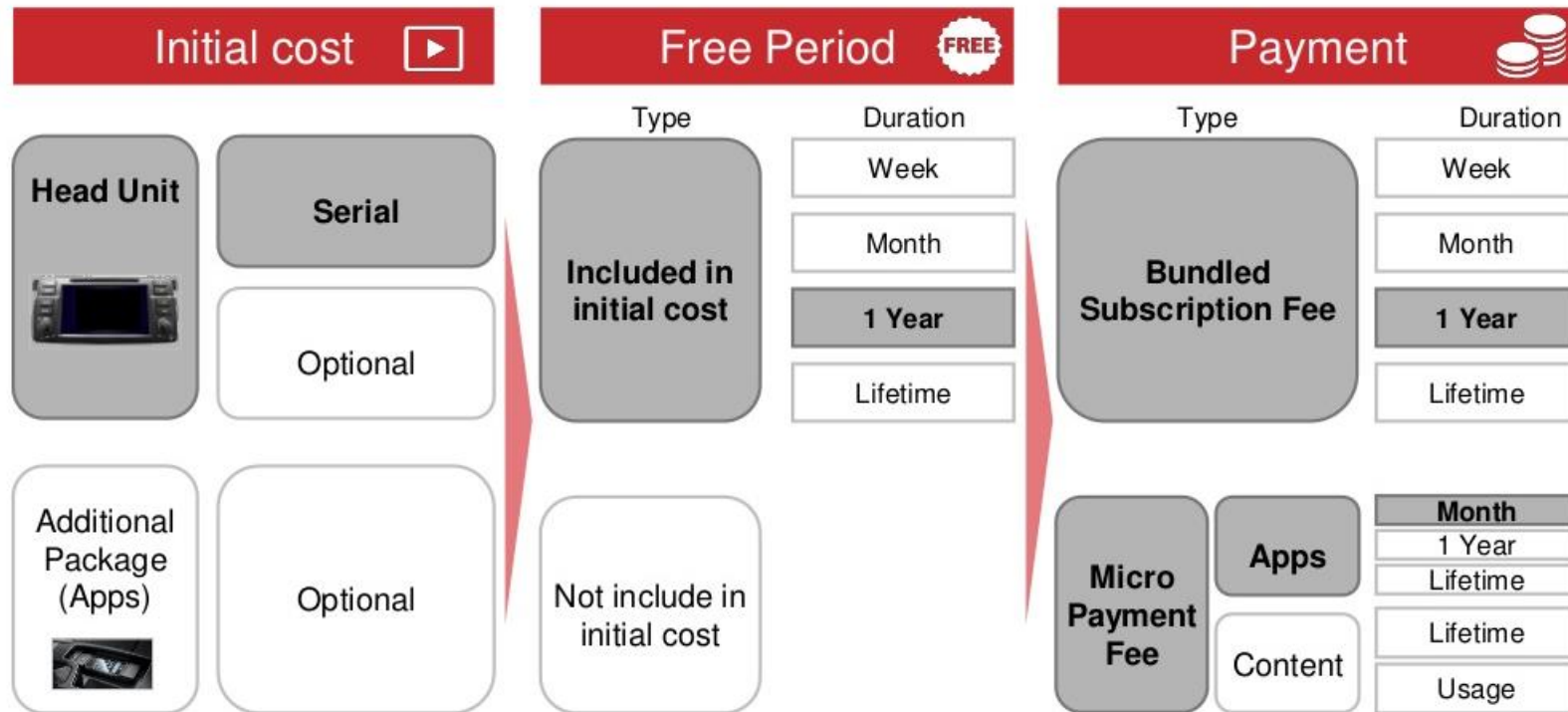
Telematics & Diagnostics



Silos getting merged and resulting in real-time, on demand services like Spotify and Connected Diagnostics among others

Source: Auto Tech Review ([link](#))

Connected Car Commercial Models



/ ... and 6 months later, the purchase of add-on service, paying a monthly fee...

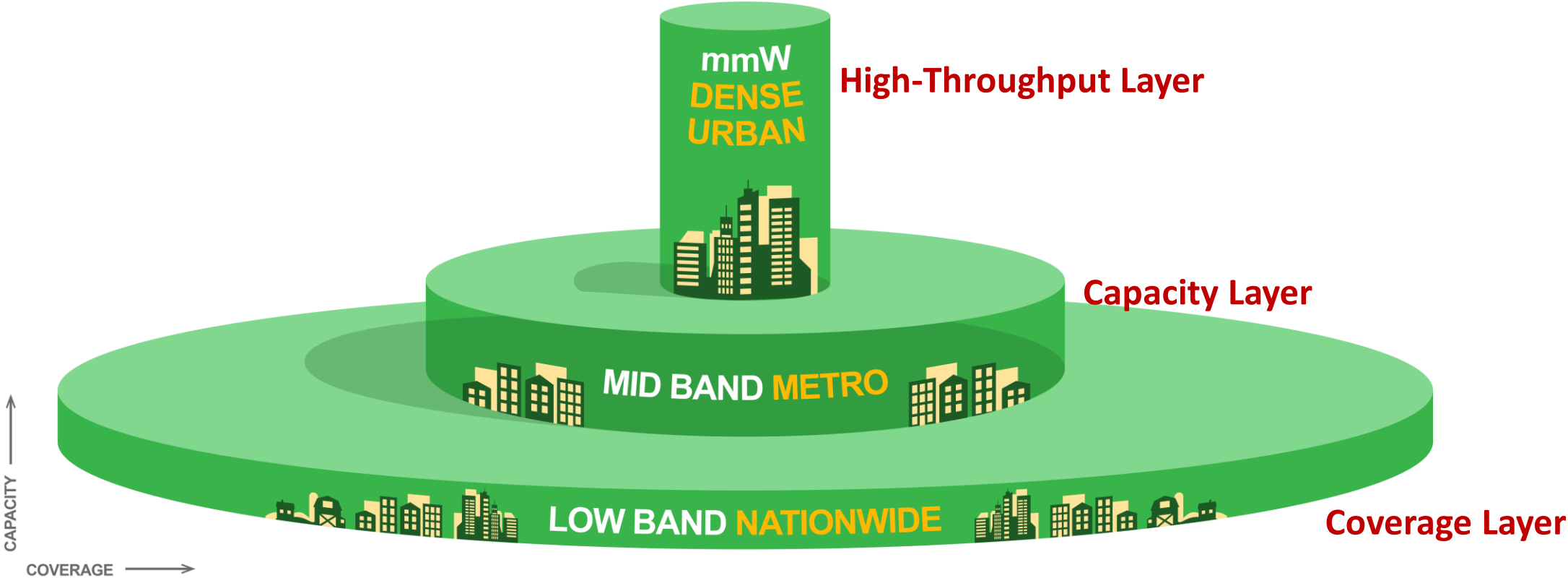


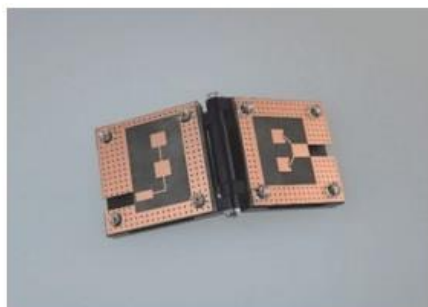
AT&T Connected Car Data Plans

AT&T data plans		
Plan	Data Included	Price
AT&T Mobile Share Value® or Mobile Share Advantage™ <small>Add vehicle to existing plan²</small>	Includes shared data*	\$10/mo. <small>Access charge**</small>
Connected Car Unlimited⁴	Unlimited <small>After 22GB of data usage, AT&T may slow speeds</small>	\$20/mo.

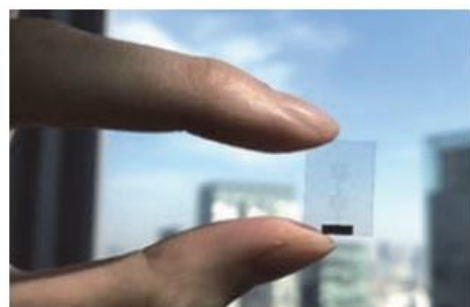
Source: AT&T OnStar® ([link](#))

5G Spectrum Layer Cake





(a) On-glass antenna



(b) Glass-integrated 5G antenna

Photo 2 The 5G vehicle glass antenna we developed



An on-glass antenna mounted on the windshield



An on-glass antenna mounted on the rear window

Photo 3 Example on-glass antenna installations

Table 1 Main specifications

5G base station equipment	Frequency	27.9 GHz
	System bandwidths	732 MHz, 366 MHz
	Duplex method	TDD (UL:DL = 2:48)
	Radio access method	OFDMA
	Antenna structure	Vertical and horizontal polarization, 2 per polarization x 128 elements
	Max. no. of MIMO streams	4
	Modulation method	QPSK, 16QAM, 64QAM
5G terminal equipment	Antenna structure	Vertical and horizontal polarization, 8 elements per polarization x 2 elements in a sub array

OFDMA: Orthogonal Frequency Division Multiple Access
QAM: Quadrature Amplitude Modulation

QPSK: Quadrature Phase Shift Keying
TDD: Time Division Duplex

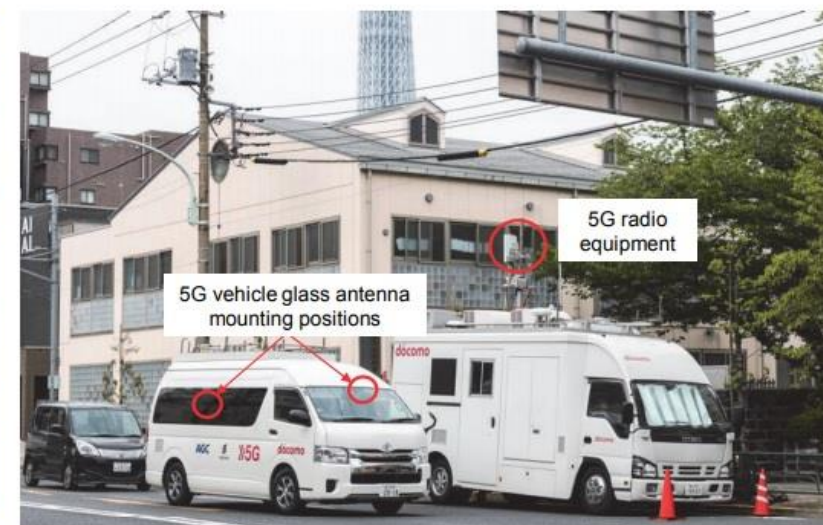


Photo 4 A scene during demonstration testing

Intelsat, Toyota & Kymeta Connected Car

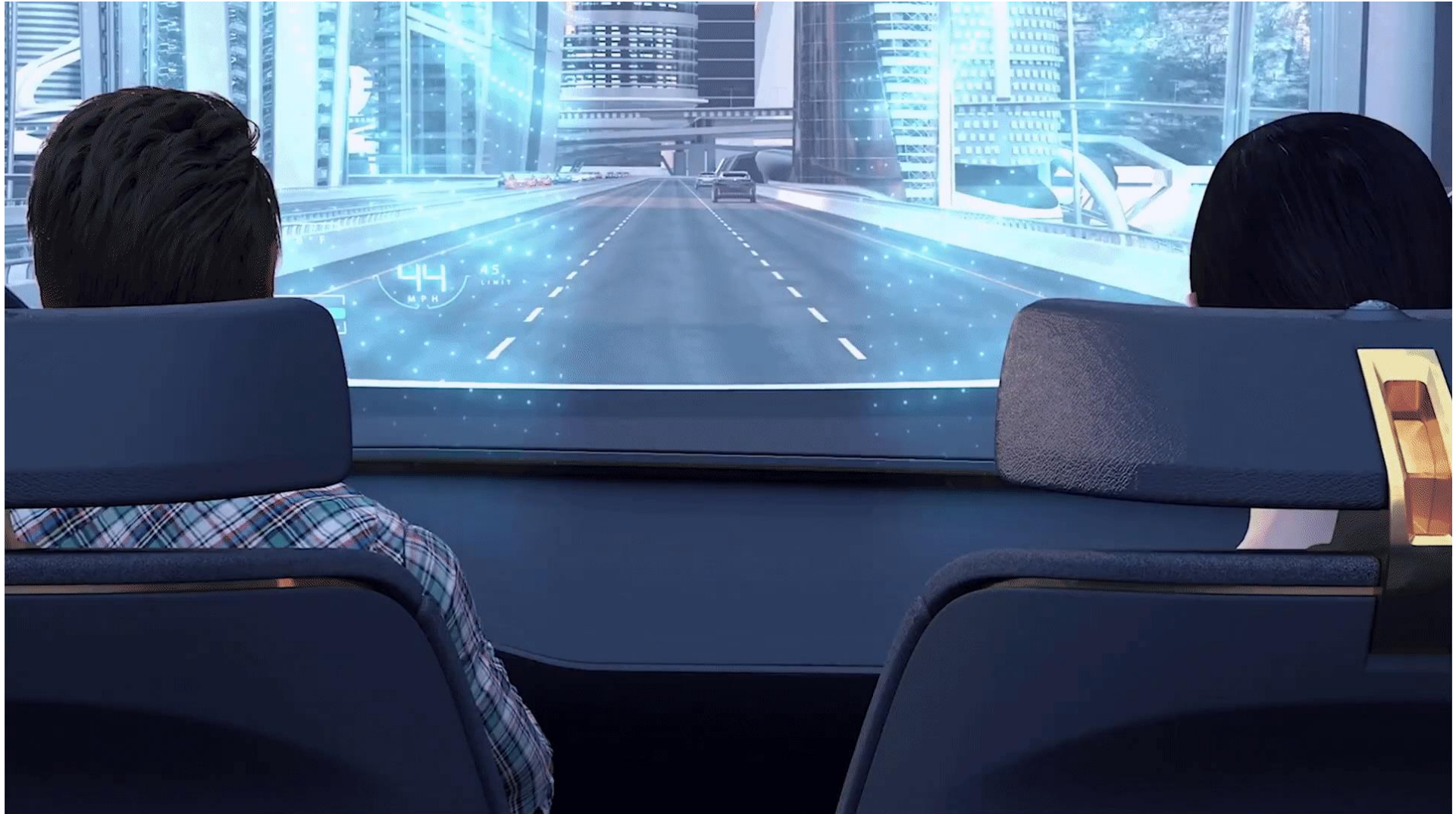
- Toyota providing the car
- Intelsat providing connectivity
- Kymeta providing flat panel antenna
- While satellite connectivity is available ubiquitously, cellular connection could also be used wherever available



Source: [Satnews](#)

More details on [Kymeta Website](#)

Autonomous Vehicles



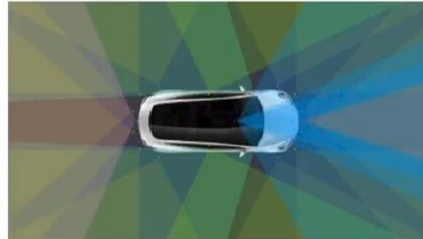
3 Levels of Autopilot

Teşla Autopilot

Autopilot is an increasingly capable suite of safety and convenience features that make personal transportation safer and more enjoyable.

Safety is Standard

- **Automatic Emergency Braking**
Detects objects that the car may impact and applies the brakes accordingly
- **Side Collision Warning**
Warns the driver of potential collisions with obstacles alongside the car
- **Front Collision Warning**
Warns of impending collisions with slower moving or stationary cars



Enhanced Autopilot

Model 3 will match speed to traffic conditions, keep within a lane, automatically change lanes, transition from one freeway to another, exit the freeway and self-park at your destination. This is a driver's assistance feature with the driver responsible for remaining in control of the car at all times.

Software has begun rolling out and features will continue to be introduced as validation is completed, subject to regulatory approval.

\$5,000

\$6,000 upgrade after delivery



Full Self-Driving Capability

In the future, Model 3 will be capable of conducting trips with no action required by the person in the driver's seat.

This functionality is dependent upon extensive software validation and regulatory approval. It is not possible to know exactly when it will be available, as this is highly dependent on local regulatory approval, which may vary widely by jurisdiction.

\$3,000

Requires Enhanced Autopilot

Model 3

CASH

LOAN

\$49,000

Before savings

\$36,416

After incentives & gas savings

Delivery in 4 weeks

NEXT

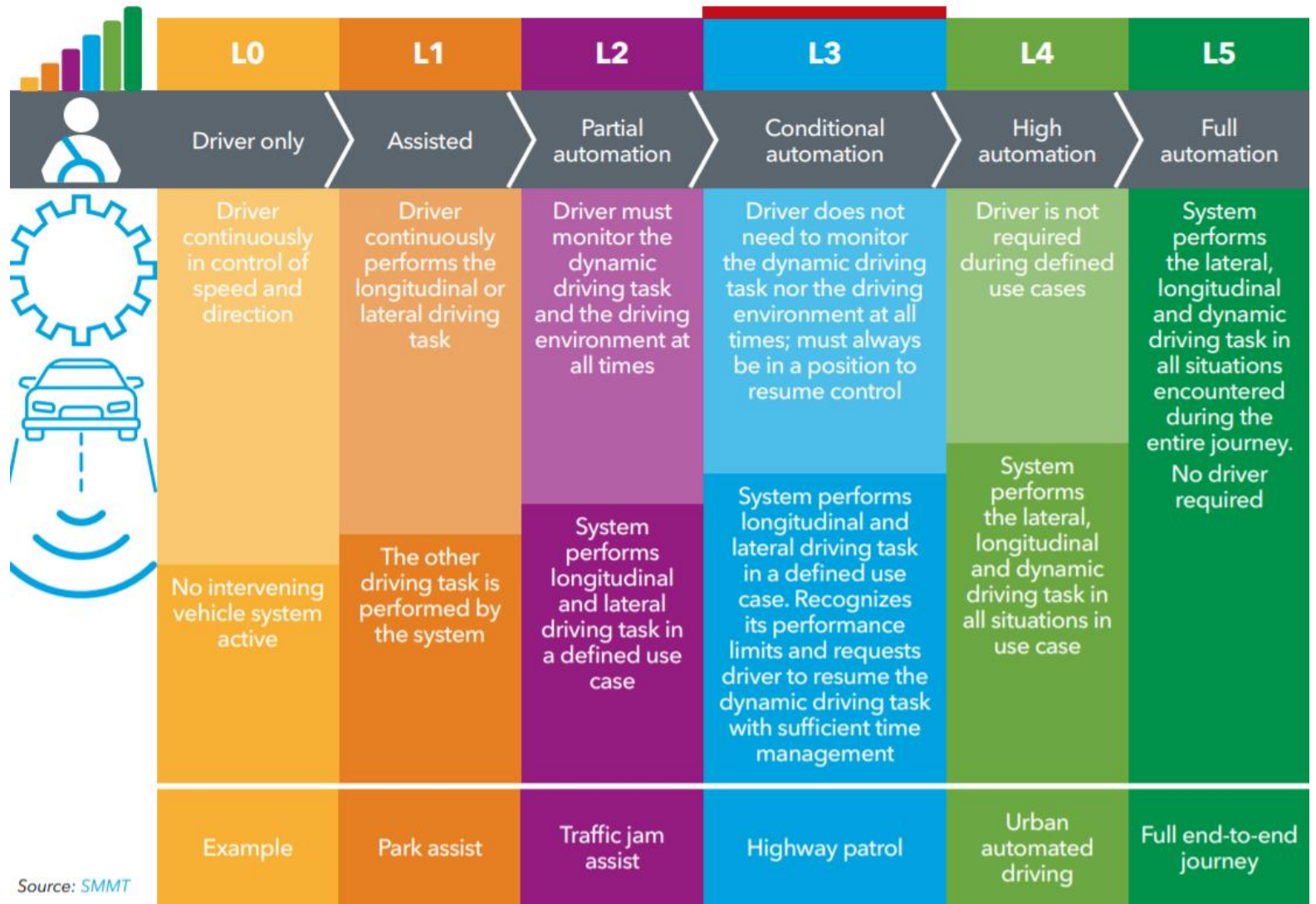
Screenshot © Matt.com

Sensors for Tesla's Autopilot



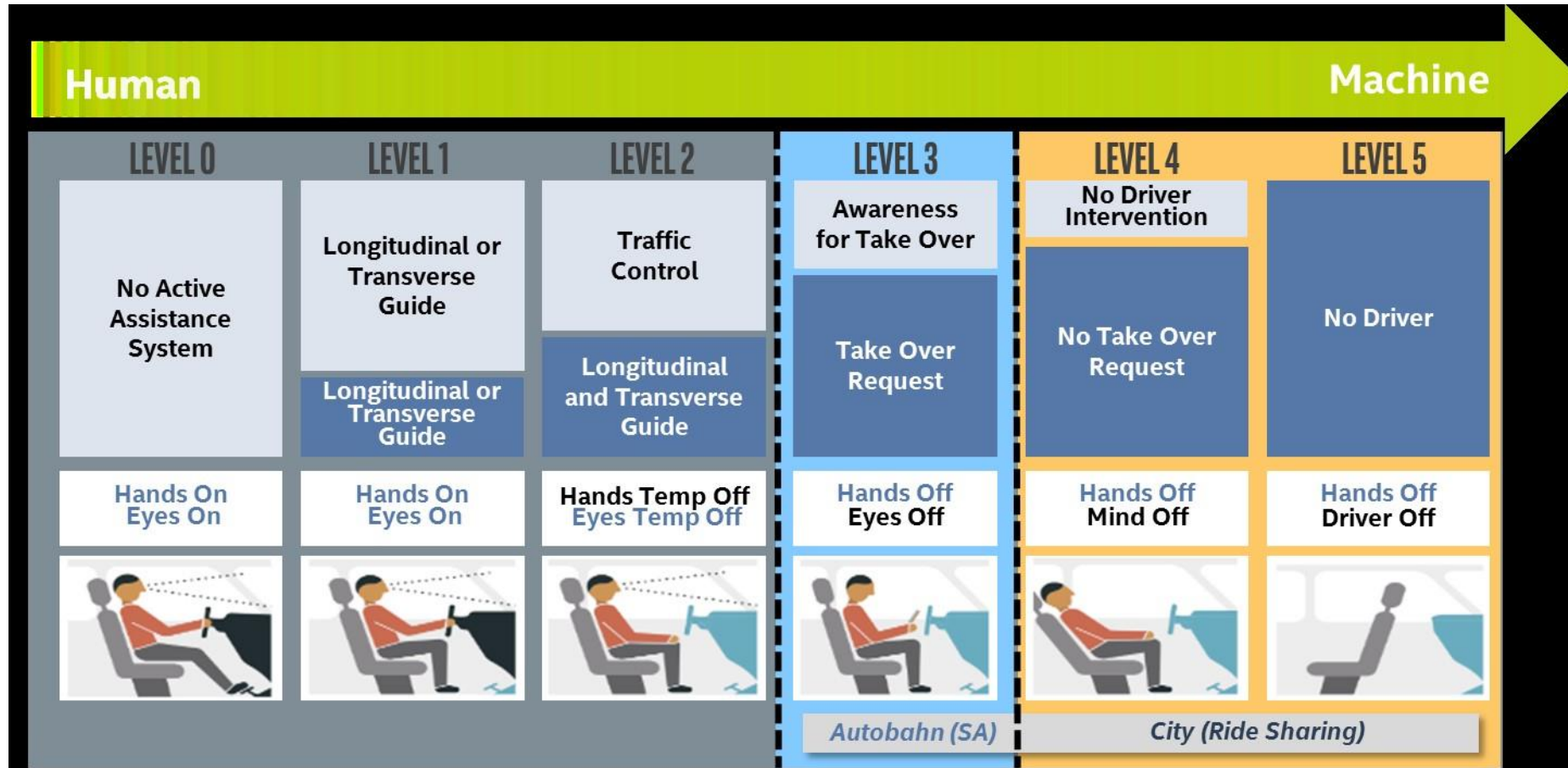
Levels of Automation

Source: SMMT

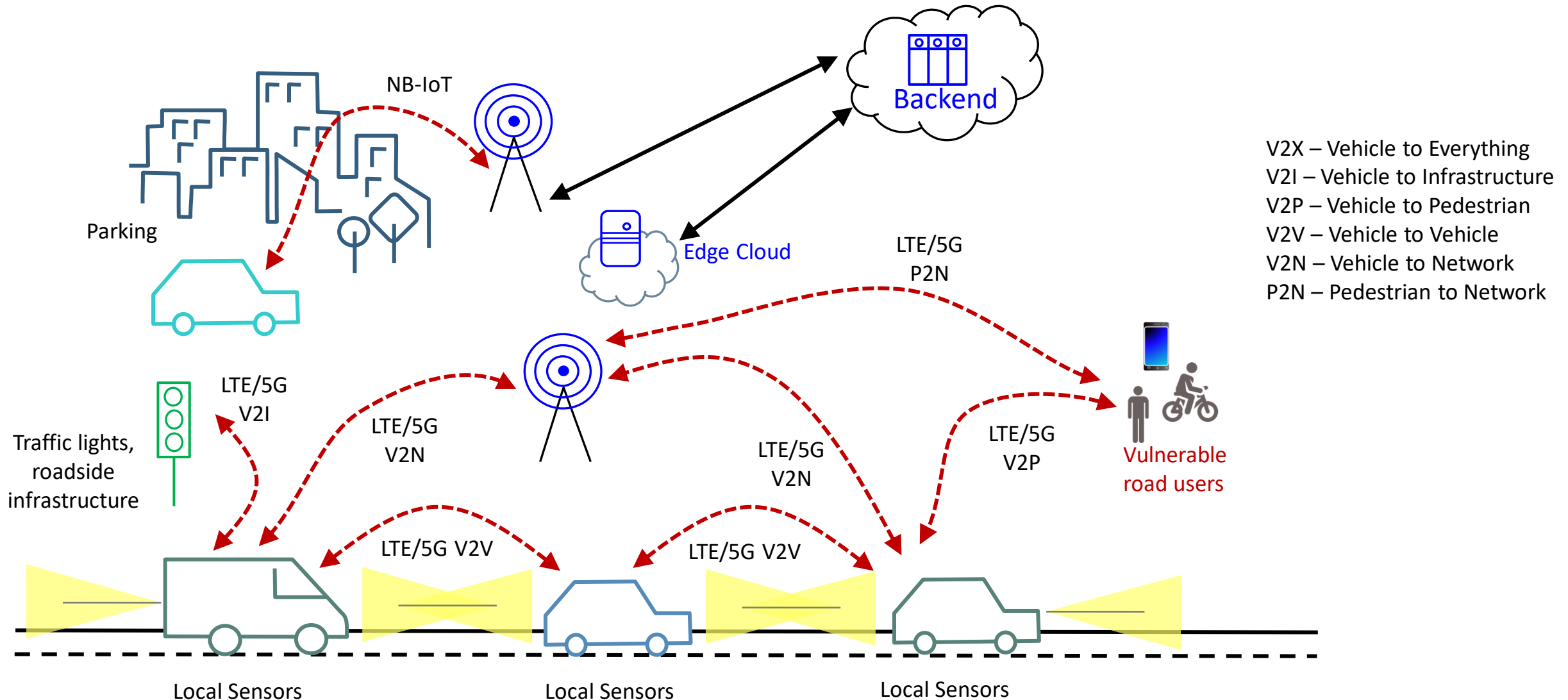


Source: SMMT

Automation: Transition of Responsibility



Cellular V2X Concept – VIDEO COMING SOON



Further Reading

- ITU News Magazine: Technology driving safer transport, Feb 2020 ([link](#))
- Verizon Connect: What is Telematics ([link](#))
- AT&T is Leading the Way on Connecting the Cars of Today and Tomorrow, Oct 2018 ([link](#))
- Connectivity Technology Blog: Futuristic Glass Antenna by NTT Docomo and AGC, Oct 2019 ([link](#))
- NTT Docomo Technical Journal: Vehicle Antenna Technology for Stable 5G Communications without Compromising Vehicle Design —5G Vehicle Glass Antennas, Vol.21 No.3, Jan. 2020 ([link](#))
- Longitudinal and lateral control for autonomous ground vehicles, June 2014 ([link](#))
- Synopsys: The 6 Levels of Vehicle Autonomy Explained ([link](#))
- Counterpoint: Connected Car Opportunity Propels Multi-Billion-Dollar Turf War, March 2018 ([link](#))

Thank You

To learn more, visit:

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Connectivity Technology Blog – <https://www.connectivity.technology/>

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